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### **Mixed Low-Level Radioactive Waste Minimization Evaluation and Strategy**

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## ACRONYMS AND INITIALISMS

CCMC	Chemical Commodity Management Center
DETF	Dilute Effluent Treatment Facility
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DP	Defense Programs
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
ER	Energy Research
FFCAct	Federal Facility Compliance Act of 1992
HEPA	high-efficiency particulate air
INEL	Idaho National Engineering Laboratory
K-25	Oak Ridge K-25 Site
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restriction
LLW	low-level radioactive waste
MLLW	mixed low-level radioactive waste
MWIR	Mixed Waste Inventory Report
ORNL	Oak Ridge National Laboratory
P2	pollution prevention
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PPOA	Pollution Prevention Opportunity Assessment
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
RMMA	Radioactive Material Management Area
SRS	Savannah River Site
STP	Site Treatment Plan
TSCA	Toxic Substances Control Act
Y-12	Oak Ridge Y-12 Plant



## EXECUTIVE SUMMARY

On September 8, 1994, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 94-2, "Conformance with Safety Standards at the DOE Low-Level Nuclear Waste Disposal Sites," which concluded that DOE's low-level radioactive waste (LLW) program required improvement. Part of this recommendation calls for "studies of enhanced methods that can be used to reduce the volume of waste to be disposed of..." (Conway 1994). In response to Recommendation 94-2, DOE developed and submitted to DNFSB an Implementation Plan that included plans to "...undertake an evaluation of its current LLW minimization efforts [which will] identify efforts that are successful in reducing the amounts of LLW requiring disposal with the purpose of developing a strategy for extending successful practices to other applications" (DOE 1995h). A Revised Implementation Plan, dated April 1996, has been provided to the DNFSB and was accepted in August 1996.

The *Low-Level Radioactive Waste Minimization Evaluation and Strategy* (DOE/ORO-2043) report supports the overall strategy for reducing low-level radioactive waste at U.S. Department of Energy (DOE) sites as outlined in the 1996 Pollution Prevention Program Plan, issued on May 3, 1996. This report supplements the DOE/ORO-2043 report findings by presenting additional recommendations for mixed low-level radioactive waste (MLLW). Many of the recommendations made in the DOE/ORO-2043 report (especially those for personal protective equipment use, investigation activities, remediation, and decommissioning) are also applicable to MLLW. While this document is not a stand-alone strategy document, it provides tactical methods for sites to use to meet the overall MLLW reduction goal, which is the strategic objective. It is the responsibility of DOE sites to implement pollution prevention and to contribute to achieving the Department-wide goal. Specific guidance on meeting this goal is provided in the 1996 Pollution Prevention Program Plan.

Clearly, there are many steps that sites must take to reach the pollution prevention goals. They include:

1. Critically evaluating all new processes/activities to determine waste generation before the process/activity is approved for start-up. The cost of waste management must be clearly understood before waste generation starts.
2. Evaluating all existing operations for potential waste reduction or replacement by new processes. The use of the Pollution Prevention Opportunity Assessment methodology is recommended to find and evaluate waste reduction concepts.



3. Changing contracting and subcontracting mechanisms to fully address waste management responsibilities and assign waste reduction goals.
4. Conducting total life cycle cost analysis of projects, including environmental restoration and decommissioning projects.
5. Assessing the cost/benefit of waste reduction activities to clearly demonstrate that pollution prevention pays.

In addition, changes to facilities, processes, and materials must take into account the overall safety and health basis for current operations. No changes should be implemented without adequate review and input from environmental, safety, and health professionals on-site.

As with any waste minimization/pollution prevention activity, the overall objective is to reduce the amount and/or toxicity (and, therefore, risk) of a current waste generation practice. The U.S. Environmental Protection Agency hierarchy of pollution prevention actions favors source reduction over recycle, and favors these actions over treatment (including volume reduction) and disposal. Where activities intended for waste minimization/pollution prevention would increase the volume of waste, the toxicity of waste, or the treatment/disposal costs, such actions should not be taken.

This strategy document is not intended to be a complete and comprehensive study of MLLW generation, treatment methods, or waste minimization options. A comprehensive study that provides "trade-offs" between treatment, recycling, and source reduction activities would require a separate effort as part of the Research and Development (R&D) Task in Section XI of the Revised Implementation Plan. Similarly, the concept of "indexing" waste generation to production activities to measure the impact of specific waste minimization activities versus waste generation changes due to reduced production will be included in future R&D tasks for Recommendation 94-2.

This report presents the results of an evaluation conducted to identify common MLLW generating activities and identifies successful MLLW minimization recommendations that can be implemented to reduce the generation of MLLW and meet the Department's MLLW reduction goal. The DOE/ORO-2043 report revealed that LLW minimization potential differed depending on a site's mission and that DOE sites can be viewed as having one of two mission types: "operating" or "environmental restoration." The same view of site missions was applied to this report for MLLW minimization potential.

Site status was identified according to the DOE program under which the sites operate. From annual reports, the most commonly identified lead organizations were Defense Programs (DP), Energy Research (ER), and Environmental Management (EM). For the purposes of this report, "operating" sites were defined as primarily operating as production or laboratory facilities under DP or ER. "Environmental restoration" sites are defined as performing primarily restoration and site cleanup activities under EM. Savannah River Site (SRS) transitioned from DP to EM landlord responsibility in 1995. During meetings with site officials it was determined that SRS is currently performing more like a restoration site. Due to this finding, SRS has been included in the environmental restoration analyses for this report.

The DOE/ORO-2043 report identified the following LLW generating activities (and the major waste minimization recommendation for each activity), in order of their overall waste minimization potential for each type of site:

- Operating sites:
  - Suspect waste<sup>1</sup>—down posting<sup>2</sup> and controlled entry
  - Personal protective equipment use—segregation and entry restrictions
  - Effluent treatment—procedural changes and carbon regeneration
  - Miscellaneous—segregation for volume reduction
- Restoration sites:
  - Remedial activities—reuse and leave in place
  - Decommissioning—recycle/reuse and free release
  - Site investigation—revise techniques and revise documentation procedures

Most of these recommendations also apply to MLLW, depending on whether the contamination at the site is strictly LLW or if it is MLLW.

Additional MLLW generation and waste minimization data were collected from 11 DOE facilities, including both operating facilities and restoration facilities as follows:

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<sup>1</sup>For the purposes of this report, suspect waste is waste that, due to the area in which it originated, is presumed to be radiologically contaminated but has not been proved (or disproved) to be radiologically contaminated.

<sup>2</sup>For the purposes of this report, any consolidation of radiological activities to reduce the size of radiological buffer areas.

- Operating sites:
  - Idaho National Engineering Laboratory
  - Los Alamos National Laboratory
  - Oak Ridge National Laboratory
  - Oak Ridge Y-12 Plant
- Restoration sites:
  - Fernald
  - Hanford
  - Oak Ridge K-25 Site
  - Paducah Site (formerly Paducah Gaseous Diffusion Plant)
  - Portsmouth Gaseous Diffusion Plant
  - Rocky Flats
  - Savannah River Site

These sites were selected because they represent EM, ER, and DP sites and are located in a broad range of geographic areas.

Three recommendations were identified for MLLW and should be applied at the site level. These activities will affect the greatest number of MLLW streams generated by each site. The site level recommendations are:

- administrative approaches,
- chemical traffic controls, and
- down posting.

Note that although down posting was identified in the DOE/ORO-2043 report, it is further discussed for MLLW due to its effectiveness and to show how it fits in a site level approach.

In addition to the site level options, the following options may be more applicable to specific sites and specific activities. The following waste generating activities were identified for MLLW reduction:

- Laboratory activities
  - modify equipment
  - reuse waste
- Equipment maintenance
  - modify equipment
  - recycle waste

- Facility maintenance
  - modify procedures
  - reuse waste
- Waste management
  - modify sampling procedures
  - divert storm water
  - reuse material
  - segregate waste
  - modify equipment
  - modify treatment procedures

These four activities were found to be common to most DOE sites regardless of whether they are operating or restoration sites.

Based on data collected and evaluated, the information derived from the case studies in Table E.1 should be implemented across the DOE complex. These activities, when implemented along with the seven identified for LLW in DOE/ORO-2043, will support the Department's Pollution Prevention Goals issued on May 3, 1996. Copies of this report will be provided to DOE sites for their use in reducing the waste from both routine operations and cleanup/stabilization activities in the future.

Table E.1. Case study examples of MLLW minimization options

Generating category	Case study	Reduction	Potential cost savings	Implementation cost
<b><u>Site level</u></b>				
Administrative Approaches	No case study			
Chemical traffic controls	Established and staffed a Chemical Commodity Management Center to track and control chemical purchases and usage	16,500 lb/year	\$250,000/year	NA
Down posting <sup>a</sup>	Down posting laboratory building	441,180 lb/year	\$1,000,000/year	\$79,535
<b><u>Activity-specific</u></b>				
Laboratory activities	Modified laboratory equipment to reduce MLLW waste generation	0.6 m <sup>3</sup> /year	\$46,000/year	\$172
	Reused acid for cleaning glassware in laboratories	4.13 m <sup>3</sup> /year	\$82,000/year	NA
Equipment maintenance	Modified existing equipment to use fabric filter belts and eliminated the use of paper belts	1,350 ft <sup>3</sup>	\$360,000/year	\$50,000
	Recycled ethylene glycol for reuse in equipment	NA	NA	NA
Facility maintenance	Modified the number of times building exhaust filters were changed	500 ft <sup>3</sup>	\$180,000	\$150,000

Table E.1 (Continued)

Generating category	Case study	Reduction	Potential cost savings	Implementation cost
	Allowed paint thinner to settle and be reused	1,000 gal	\$40,000	NA

Table E.1 (Continued)

Generating category	Case study	Reduction	Potential cost savings	Implementation cost
Waste management	Revised Part A permit to allow for longer storage of waste, thereby reducing the number of samples taken	7.5 m <sup>3</sup>	\$200,000	\$40,000
	Segregated material from existing waste and reduced the amount of MLLW disposed of	119.5 m <sup>3</sup>	\$355,000/year	<\$100
	Reused lead shielding during another project	50 ft <sup>3</sup>	NA	NA
	Installed canopies over dikes and reduced the volume of MLLW	287,000 gal	\$1,704,000	NA
	Upgraded facility to provide on-demand pressurized water and reduced the MLLW generated	1.6 m <sup>3</sup>	\$4,400	\$2,500
	Used in-stock chemicals to neutralize waste	201 ft <sup>3</sup> /year	NA	\$1,000–10,000

NA = data not available

<sup>a</sup>The case study specifics are not included in this document but may be obtained from DOE/ORO-2043.